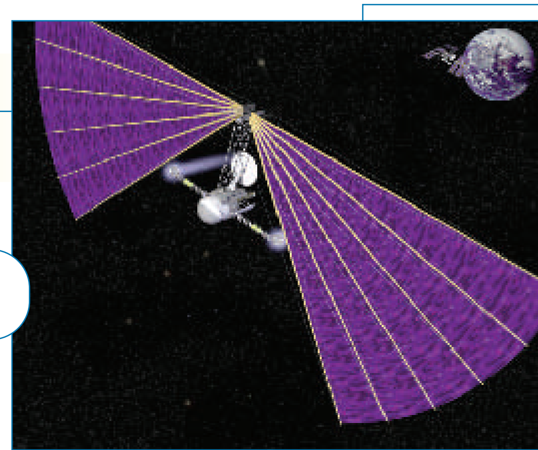
Advanced Space Transportation Technology Summary



Electric Propulsion

In the early 1990s, NASA identified electric propulsion as a prime enabling technology for future deep space missions, and began developing and testing various electric propulsion technologies. Intended to reduce fuel weight, decrease travel times to other planets and permit larger scientific payloads, electric propulsion technologies may be the key to our continued exploration of Earth's neighboring worlds.

Electric propulsion technologies generate thrust via electrical energy that may be derived either from a solar source, such as solar photovoltaic arrays, which convert solar radiation to electrical power, or from a nuclear source, such as a space-based fission drive, which splits atomic nuclei to release large amounts of energy.

This energy is used to accelerate an on-board propellant by one of three processes:

- Electrostatic power, or the production of static electricity
- Electromagnetic power, or the production of magnetism via electricity
- Electrothermal power, or the production of heat via electricity

These processes convert the accelerated propellant to spacecraft kinetic energy, or thrust.

Currently, more mature electric propulsion technologies typically considered for in-space use in Earth orbit and beyond include:

- Plasma-based, xenon-fueled Hall thrusters
- Solid Teflon-fueled pulsed plasma thrusters
- Ammonia-fueled arcjet thrusters
- Superheated water or nitrous oxide-fueled resistojets
- Xenon-fueled ion thrusters

The latter powers Deep Space 1, NASA's successful ion propulsion vehicle, which now cruises the solar system 137 million miles (220 million kilometers) from Earth, testing in-space hardware and electric propulsion capabilities.

Other devices, such as magneto-plasma-dynamic thrusters, VASIMR and pulsed induction thrusters, may offer future primary propulsion benefits for higher-power nuclear propulsion systems.

Spacecraft powered by typical electric propulsion systems may eject propellant at up to 20 times the speed of conventional chemical systems, delivering a much higher specific impulse, or the amount of thrust obtained for the weight of fuel burned. Electric-based systems also require far less propellant mass than traditional, chemical-propelled craft.

In addition, deep-space missions no longer would be constrained by narrow launch windows dictated by planetary alignment. Traditionally, chemical-propelled spacecraft move from planet to planet as they travel, using "gravity-assist" maneuvers in each world's orbit to increase their own velocity and "sling-shot" on toward their final destination. A mission to Neptune or Pluto, for example, could make straight for its intended target, rather than "touring" the outer planets to help boost its velocity as it travels.

Spacecraft using electric propulsion systems—from ion engines to fission propulsion drives—may enable a host of future interplanetary missions, from long-duration studies of Europa and other Jovian moons, Pluto and other large bodies in the outer solar system, to low-power, automated missions to visit comets and other smaller bodies.

NASA's Electric Propulsion team includes researchers from Glenn Research Center in Cleveland, Ohio; the Jet Propulsion Laboratory in Pasadena, Calif.; Johnson Space Center in Houston, Texas; Marshall Space Flight Center in Huntsville, Ala.; and leading-edge partners in other government agencies, industry and academia. The Marshall Center manages NASA's Space Transportation Program, including the Advanced Space Transportation Program and the In-Space Propulsion investment area.

For more information about NASA Space Transportation Systems, visit: **http://www.spacetransportation.com**